

Cardiopulmonary Bypass in Cyanotic Patients



A Review of the Problems and
Suggested Strategies

Cardiopulmonary Bypass in Cyanotic Patients

Extra-ordinary Problems Encountered During C.P.B. for Cyanotic Heart Disease

1. Extra Dilutional Requirements
2. Predisposition to Post-operative Bleeding
3. ↑ Numbers of Collateral Vessels
4. Re-oxygenation Injury
5. Others

Cardiopulmonary Bypass in Cyanotic Patients

1. Dilution

- ↓ Viscosity
- ↑ Shear rates
- ↑ Perfusion
- ↓ Blood requirements in priming

Cardiopulmonary Bypass in Cyanotic Patients

1. Dilution

Generally: 20 - 40% or
20 - 40ml/kg.

Cyanotic patients require greater dilution
in order to:

- ↓ viscosity
- ↑ shear rates
- ↑ perfusion

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1. Dilution

in cyanotic patients

- ↓ Oxygen Carrying Capacity
- ↓ Leucocyte & Platelet Numbers
- ↓ Coagulation Proteins
- ↓ Plasma Oncotic Pressure
- ↑ Diuresis

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Turner-Gomes S.O., Williams W.G., et al

J. Thor. C.V. Surg. 107 (2), 1994

- Thrombin Regulation & Activity
- Cyanotic Patients
 - Higher Risk of Haemorrhage
 - Dilutional in Origin

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Milam, J.D., Cooley, D.A., et al

J. Thor. C.V. Surg. 89 (4), 1985

111 Patients

Group 1: Non-cyanotic	Normal Dilution	Hb < 10
Group 2: Cyanotic	Normal Dilution	Hb > 10
Group 3: Cyanotic	Dilution To Below 10gm%	Hb < 10

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MILAM et al. - Results

- At 24 Hrs Grp3 Hct > Grp 1 (↑ Diuresis)
- Grp 3 Platelets Only ↓ To 106,000
- Grp 3 Fibrinogen, Factors X, Ix, Vii, V, Ii All ↓
And
- Grp 3 Aptt & Pt Prolonged
But
- Grp 3 Bld. Loss 45% Less Than Grp 2
And
- Grp 3 Bld. & Bld. Product Usage 54% Less Than Grp 2
- Grp 3 Re-op (Bleeding) 14%
- Grp 2 Re-op (Bleeding) 40%

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MILAM et al. - Findings

- Haemodilution Is A "Must"
- Suggests Albumin Or F.F.P.

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2. Post - Operative Bleeding In Cyanotic Patients.....

- ↑ erythrocyte number
↓ plasma volume & ↓ clotting factors
leucocytes, platelets
- hepatic congestion
(secondary to c.h.d.)
↓ production of clotting factors

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2. Post - Operative Bleeding In Cyanotic Patients.....

- ↓ Clot Retraction
 - ? Hypo-fibrinogenaemia
- ↓ Platelet Aggregation
 - Inverse Relationship
 - ? Cause
- Implicated In Low Grade D.I.C.

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2. Post - Operative Bleeding

In Cyanotic Patients.....

Rinder et. al. (J.Thorac.Card.Vasc.Surg. 107[1],1994)

– Found

Cyanotic Patients - Baseline GP Ib Receptor Deficit

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2. Post Operative Bleeding

Whilst On C.P.B.

- ↑ Dilution of platelets, clotting factors
- ↑ Cardiotomy suction
 - Platelet damage/dysfunction
 - Thromboxane & ADP release
- C.P.B. Itself
 - Platelet dysfunction
 - Protein damage

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2. Post Operative Bleeding

Zonis et al. (J.Thorac.Card.Vasc.Surg. 111[5],1996)

- Preoperative tranexamic acid

Significant reduction in post-op blood loss and blood product requirements.

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3. Increased Collateral Return

Cyanosis Often Means....

- ↑ Blood in I.A.

- ↓ Systemic flow

- ? ↑ pump output

- ↓ Visibility in operative field

- ? ↓ pump output

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3. Increased Collateral Flow

- ↑ Cross-clamp times
- ↑ Cardiotomy suction
- ↑ Rewarming of myocardium

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4. Re-oxygenation Injury

Buckberg Group

- Eur. J. Card. Thor. Surg 9(8), 1995
- J. Clin. Invest. 93(6), 1994

- Rapid ↑ in oxygenation of hypoxic tissue
 - ✓ ↑ Cytotoxics (No, OFRS, PO-NO₃)
 - Negates effects of beneficial CPS
- CPB in hypoxaemic pts. **MUST** be instigated using lowest pO₂

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5. Cyanosis - Other Considerations

Wong, P.C., Jonas, R.A., et al.

Circulation. 86(5) (Supp II), 1992

Choreoathetosis & CPB

- Found:
 - Higher incidence in cyanotic patients with systemic to pulmonary collaterals

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5. Cyanosis - Other Considerations

Silverman, N.A., Kohler, J., et al.

Ann. Thor. Surg. 37(4), 1984

Cyanotic dog model

– Found:

↓ global ventricular function

↓ ATP stores

– Suggests cyanotic patients at higher risk

– ? Special CPS needed (cf Buckberg)

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5. Cyanosis - Other Considerations

del Nido, P.J., Trusler, G.A., et al.

J. Thor. C.V. Surg. 95(2), 1988

	Cyanotic Grp	Non-cyanotic Grp
Mean Age	6.3 yrs	54 yrs
Haemoglobin	15.5 gm/dl	11.0 gm/dl
X-Clamp Time	41 min	70 min
Pre-Clamp ATP	24 mmol/kg dry wt.	16 mmol/kg/ dry wt
Myocardial Temp	12.5 deg C	16.9 deg C

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del Nido et al. - Results

- After Similar Myocardial Protection

 - ↓ ATP Levels

 - ↑ Lactate levels

- Histopathology In Cyanotic Group

 - Focal myocyte necrosis

 - Presence of contraction bands

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del Nido et al.

Suggests:

- Cyanotic patients are more susceptible to ischaemic insult and to reperfusion injury
- May have a defect in oxidative metabolism
- ? Improved cps needed (cf Buckberg)

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Summary

- Dilute adequately
- Maintain protein levels on C.P.B
- Cooling
- Prepare for post-operative bleeding
- Introduce CPB appropriately
- ? Research into appropriate protocols for cyanotic patients

Cardiopulmonary Bypass in Cyanotic Patients

Antioxidant supplementation of the CPB prime avoids unintended reoxygenation injury and results in improved biochemical and functional status.

Ihnken K. Buckberg GD. et al

Cardiovascular Surgery. 5(6):608-19, 1997